

9 a sensing assembly to measure manipulation of said captured peripheral and transmit
10 information associated with said manipulation to the simulation system to simulate performance of
11 the medical procedure with said corresponding medical instrument in accordance with said measured
12 manipulation.

1 86. The apparatus of claim 85 wherein said medical instrument includes an endoscope.

1 87. The apparatus of claim 85 wherein said peripheral includes a nested instrument
assembly, and said interface apparatus further includes:

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CONT. 3
4 a plurality of capture mechanisms each engaging a corresponding instrument of said
instrument assembly to enable said interface apparatus to measure manipulation of that
5 instrument; and

6 a plurality of sensing assemblies each measuring manipulation of a corresponding
7 captured instrument of said instrument assembly.

1 88. The apparatus of claim 85 further including a pivoting mechanism to pivot said
2 orifice.

1 89. An interface device for interfacing instruments to a simulation system to enable a user
2 to interact with the simulation system to perform a medical procedure on a simulated anatomy of a
3 virtual patient, said interface device comprising:

4 a plurality of peripherals in the form of mock medical instruments capable of selective
5 manipulation by the user;

6 a plurality of orifices for receiving said instruments;

7 a plurality of guide tubes for directing said instruments from said orifices into said interface
8 device;

9 a plurality of capture mechanisms for engaging said instruments to enable said interface
10 device to measure manipulation of and provide force feedback to said instruments; and

11 a plurality of sensing assemblies to measure manipulation of and provide force feedback to
12 said instruments, wherein each said sensing assembly includes:

13 motion detection means to measure manipulation of a corresponding captured
14 instrument and provide signals indicating said measured manipulation to said simulation
15 system to simulate said medical procedure; and

16 force application means to apply force feedback to said corresponding captured
17 instrument in response to control signals from said simulation system.

1 90. The device of claim 89 wherein at least one of said instruments includes a nested
2 instrument assembly.

1 91. In an interface apparatus for operatively interconnecting a peripheral corresponding
2 to a medical instrument to a simulation system to enable a user to interact with the simulation system
3 to perform a medical procedure on a simulated anatomy of a virtual patient, wherein said interface
4 apparatus includes a sensing assembly to measure manipulation of said peripheral and transmit

5 information associated with said manipulation to the simulation system, a capture mechanism for
6 engaging a peripheral inserted within the interface apparatus to enable the interface apparatus to
7 measure manipulation of that peripheral, said capture mechanism comprising:

8 a grasping member for engaging said peripheral to enable said interface apparatus to measure
9 manipulation of said peripheral; and

10 an actuator for activating said grasping member to engage said peripheral in response to
11 manipulation of said peripheral into said grasping member.

1 92. In an interface having a peripheral selectively manipulable by a user and
2 corresponding to a medical instrument and a sensing assembly to measure manipulation of the
3 peripheral, a method of enabling the user to interact with the simulation system, via the interface,
4 to perform a medical procedure on a simulated anatomy of a virtual patient comprising the steps of:

5 (a) inserting the peripheral into said interface via an orifice, and selectively manipulating
6 said peripheral within said interface;

7 (b) engaging said peripheral, via a capture mechanism, to enable said interface to measure
8 manipulation of said peripheral;

9 (c) measuring manipulation of said captured peripheral via the sensing assembly; and

10 (d) transmitting information associated with the measured manipulation from the interface
11 to the simulation system to simulate performance of the medical procedure with the corresponding
12 medical instrument in accordance with the measured manipulation.

1 93. The method of claim 92 wherein said medical instrument includes an endoscope.

1 94. The method of claim 92 wherein said peripheral includes a nested instrument
2 assembly, and step (b) further includes:

3 (b.1) engaging each instrument of said nested instrument assembly to enable said
4 interface to measure manipulation of that instrument;

5 step (c) further includes:

6 (c.1) measuring manipulation of each said instrument of the nested instrument
7 assembly; and

8 step (d) further includes:

9 (d.1) transmitting information associated with the measured manipulation of each
10 said instrument of the nested instrument assembly from the interface to the simulation system
11 to simulate performance of the medical procedure with the corresponding medical instrument
12 in accordance with the measured nested instrument assembly manipulation.

1 95. The method of claim 92 wherein step (a) further includes:

2 (a.1) pivoting said orifice to a desired orientation.

1 96. The apparatus of claim 85 further including:

2 a coupling mechanism for receiving said peripheral from said orifice and operatively
3 coupling said peripheral to said sensing assembly via said capture mechanism, wherein said coupling
4 mechanism includes dimension adjustment means for automatically adjusting coupling mechanism
5 dimensions in response to translational manipulation of said peripheral relative to said interface
6 apparatus.

1 97. The apparatus of claim 85 wherein said sensing assembly includes:
2 a force feedback unit to apply force feedback to said peripheral in response to control signals
3 from said simulation system.

1 98. The apparatus of claim 96 further including:
2 a mock anatomical site having said orifice for receiving said peripheral and providing access
3 to said coupling mechanism; and
4 a pivoting mechanism to selectively pivot said mock anatomical site into a particular
5 orientation to perform the medical procedure.

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cont.
1 99. The apparatus of claim 96 further including:
2 a mock anatomical site having said orifice for receiving said peripheral;
3 a block of resilient material disposed between said mock anatomical site and said coupling
4 mechanism; and
5 a guide tube extending from said orifice through said block to said coupling mechanism to
6 guide said peripheral within said interface apparatus;
7 wherein said block provides resiliency to simulate forces and movement of said orifice
8 encountered during performance of the medical procedure.

1 100. The apparatus of claim 99 wherein said resilient material includes foam.

1 101. The apparatus of claim 85 wherein said corresponding medical instrument includes an

2 endoscope, and said medical procedure is an endoscopic procedure.

1 102. The apparatus of claim 101 wherein said peripheral is in the form of an endoscope and
2 includes:

3 a working channel;

4 a working channel peripheral selectively manipulable by the user and corresponding to a
5 working channel tool; and

6 a sensor to measure manipulation of said working channel peripheral and transmit
7 information associated with said working channel peripheral manipulation to the simulation system
8 to enable the simulation system to simulate performance of the medical procedure with said
9 corresponding working channel tool in accordance with said working channel peripheral
10 manipulation.

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1 103. The apparatus of claim 102 wherein said peripheral further includes a working channel
2 force feedback unit to apply force feedback to said working channel peripheral.

1 104. The apparatus of claim 101 wherein said peripheral is in the form of an endoscope and
2 includes:

3 a navigation tube for insertion into the interface apparatus to traverse the simulated anatomy
4 of the virtual patient, wherein a distal end of said navigation tube corresponds to a medical tool;

5 a tube position control peripheral selectively manipulable by the user and associated with
6 the distal end of said navigation tube; and

7 a sensor to measure manipulation of said tube position control peripheral and transmit
8 information associated with said tube position control peripheral manipulation to the simulation
9 system to enable the simulation system to simulate flexing of said navigation tube distal end and
10 operation and positioning of said medical tool within the simulated anatomy during performance of
11 the medical procedure in accordance with said tube position control peripheral manipulation.

1 105. The apparatus of claim 85 wherein:

2 said peripheral includes a plurality of nested instruments each selectively manipulable by the
3 user and corresponding to a medical instrument;

4 said interface apparatus further includes a plurality of said capture mechanisms to engage
5 said nested instruments; and

6 said sensing assembly includes peripheral sensing means for measuring manipulation of each
7 captured nested instrument within the simulated anatomy and providing information associated with
8 said nested instrument manipulation to the simulation system to enable the simulation system to
9 simulate performance of the medical procedure with said corresponding medical instruments in
10 accordance with said nested instrument manipulation.

1 106. The apparatus of claim 85 further including a plurality of peripherals each selectively
2 manipulable by the user and corresponding to a medical instrument and a plurality of said capture
3 mechanisms to engage said plurality of peripherals;

4 wherein said sensing assembly includes peripheral sensing means for measuring
5 manipulation and detecting insertion and removal of each peripheral within the simulated anatomy

6 and providing information associated with manipulation, insertion and removal of each said
7 peripheral to the simulation system to enable the simulation system to simulate performance of the
8 medical procedure with said corresponding medical instruments and exchange of said corresponding
9 medical instruments during the medical procedure in accordance with said manipulation, insertion
10 and removal of said peripherals.

1 107. The apparatus of claim 96 further including a force feedback unit to apply force
2 feedback to said peripheral in response to control signals from said simulation system.

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CONT.
2 108. The apparatus of claim 85 wherein said capture mechanism includes:

a grasping member for engaging said peripheral; and

3 an actuator for actuating said grasping member to engage said peripheral in response to
4 manipulation of said peripheral into said grasping member.

1 109. The apparatus of claim 108 wherein said grasping member includes a tubular member
2 to receive said peripheral, and said actuator includes:

3 a spring to elongate and compress said tubular member in response to translational
4 manipulation of said peripheral relative to said interface apparatus to facilitate adjustment of tubular
5 member cross-sectional dimensions;

6 wherein expansion of said spring in response to insertion of said peripheral within said
7 interface apparatus elongates said tubular member, thereby decreasing said tubular member cross-
8 sectional dimensions to engage said peripheral, and wherein compression of said spring in response

9 to withdrawal of said peripheral from said interface apparatus compresses said tubular member,
10 thereby increasing said tubular member cross-sectional dimensions to release said peripheral.

1 110. The apparatus of claim 108 wherein:

2 said capture mechanism is disposed within said sensing assembly;

3 said grasping member includes a plurality of jaws defined in a distal portion thereof to
4 surround and engage said peripheral; and

5 said actuator includes:

6 a spring disposed over said grasping member to bias said jaws to a normally closed
state;

7 an expander disposed proximate said spring and having a conical distal end to
8 manipulate said jaws to enter open and closed states; and
9

10 a pivotable actuator disposed proximate said expander to manipulate said expander
11 to overcome said spring bias and control actuation of said jaws for entry into said closed and
12 open states for capturing and releasing said peripheral.

1 111. The apparatus of claim 110 wherein said capture mechanism further includes:

2 an automatic capture and release mechanism to automatically actuate said jaws to capture
3 and release said peripheral.

1 112. The apparatus of claim 111 wherein said automatic capture and release mechanism
2 includes:

3 a rod connected to said sensing assembly via a friction bracket;
4 a pivotable bracket disposed on said sensing assembly proximate said rod;
5 an actuator extension coupled to said pivotable actuator to control actuation of said jaws to
6 capture and release said peripheral;
7 a support bracket disposed on said rod for manipulating said actuator extension to control
8 actuation of said jaws;
9 a bracket spring disposed between said sensing assembly and said pivotable bracket to apply
10 force to said pivotable bracket to pivot that bracket about said support bracket and manipulate said
11 actuator extension relative to said support bracket to control actuation of said jaws in response to
12 insertion and withdrawal of said peripheral within said interface apparatus;
13 wherein said grasping member captures said peripheral in response to said actuator extension
14 being forced against said support bracket by said pivotable bracket and said bracket spring and
15 releases said peripheral in response to said actuator extension being forced away from said support
16 bracket by said pivotable bracket and said bracket spring.

1 113. The apparatus of claim 112 wherein said peripheral includes a plurality of nested
2 instruments each selectively manipulable by the user and corresponding to a medical instrument, and
3 said interface apparatus further includes:

4 a plurality of said sensing assemblies, each including said capture mechanism and associated
5 with a corresponding nested instrument for engaging and measuring manipulation of that nested
6 instrument and providing information associated with manipulation of that nested instrument to the
7 simulation system to enable the simulation system to simulate performance of the medical procedure

8 with said corresponding medical instruments in accordance with said nested instrument
9 manipulation; and

10 wherein said friction bracket of each said sensing assembly capture mechanism includes a
11 selectively adjustable friction member to adjust frictional forces between that friction bracket and
12 a corresponding capture mechanism rod to control resistance applied by that sensing assembly to
13 translational motion of said corresponding nested instrument;

14 wherein said friction member simulates frictional forces encountered between nested
15 instruments during performance of the medical procedure.

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cont.
1 114. The apparatus of claim 107 wherein:

2 said dimension adjustment means includes an inner tubular member and an outer tubular
3 member, wherein said inner tubular member is disposed within said outer tubular member and slides
4 relative to said outer tubular member to automatically adjust said coupling mechanism dimensions
5 in response to translational manipulation of said peripheral relative to said interface apparatus;

6 said capture mechanism is disposed at a proximal end of said inner tubular member to engage
7 said peripheral; and

8 a distal end of said inner tubular member is attached to said sensing assembly, wherein said
9 inner tubular member is manipulated in accordance with said peripheral manipulation and said
10 sensing assembly measures said peripheral manipulation by measuring manipulation of said inner
11 tubular member.

1 115. The apparatus of claim 114 further including first and second supports, wherein said

2 sensing assembly includes:

3 first and second pulleys disposed on said first and second supports, respectively;

4 a belt disposed about and between said first and second pulleys;

5 a peripheral motion assembly attached to said belt and said inner tubular member distal end
6 to facilitate measurement of manipulation of said inner tubular member to measure said peripheral
7 manipulation, wherein said peripheral motion assembly is movable between said first and second
8 supports in response to translational manipulation of said peripheral relative to said interface
9 apparatus and further includes a rotation sensor to measure rotational motion of said peripheral by
10 measuring rotational motion of said inner tubular member; and

11 a translation sensor disposed proximate said first pulley to measure translational motion of
12 said peripheral by measuring rotation of said first pulley, wherein said peripheral motion assembly
13 manipulates said belt to rotate said first and second pulleys during movement between said first and
14 second supports in response to said translational manipulation of said peripheral;

15 wherein said force feedback unit is disposed proximate said second pulley to apply force
16 feedback to said peripheral in response to control signals from said simulation system by controlling
17 rotation of said second pulley, wherein said second pulley applies a force to said belt in response to
18 said controlled rotation to control translational motion of said peripheral motion assembly, and
19 thereby control translational motion of said peripheral.

1 116. The apparatus of claim 109 further including bias means for biasing said capture
2 mechanism to an open state to enable entry and release of said peripheral within said capture
3 mechanism.

1 117. The apparatus of claim 116 further including first and second supports and a coupling
2 mechanism for receiving said peripheral from said orifice and operatively coupling said peripheral
3 to said sensing assembly via said capture mechanism, wherein said sensing assembly is disposed
4 between said first and second supports and said capture mechanism is disposed at a proximal end
5 of said coupling mechanism, and wherein said bias means includes:

6 a first magnet attached to a distal portion of said coupling mechanism; and

7 a second magnet attached to said first support;

8 wherein attraction forces of said first and second magnets bias said spring to a compressed
9 state to facilitate increased cross-sectional dimensions of said tubular member and entry and release
10 of said peripheral within said capture mechanism.

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cont.
1 118. The apparatus of claim 107 wherein said dimension adjustment means includes
2 stabilization means for stabilizing said peripheral against buckling during manipulation of said
3 peripheral within said interface apparatus to perform the medical procedure.

1 119. The apparatus of claim 118 wherein:

2 said stabilization means includes an inner tubular member and an outer tubular member,
3 wherein said inner tubular member is disposed within said outer tubular member and slides relative
4 to said outer tubular member to stabilize said peripheral against buckling and to automatically adjust
5 said coupling mechanism dimensions in response to translational manipulation of said peripheral
6 relative to said interface apparatus; and

7 a distal end of said inner tubular member is attached to said sensing assembly to operatively

8 couple said peripheral to said sensing assembly.

1 120. The apparatus of claim 118 further including first and second supports, wherein said
2 sensing assembly includes:

3 first and second pulleys disposed on said first and second supports, respectively;

4 a belt disposed about and between said first and second pulleys;

5 a peripheral motion assembly attached to said belt and said stabilization means to facilitate
6 measurement of said peripheral manipulation and including said capture mechanism to engage said

7 peripheral, wherein said peripheral motion assembly is movable between said first and second
8 supports in response to translational manipulation of said peripheral relative to said interface
9 apparatus and further includes a rotation sensor to measure rotational motion of said peripheral; and

10 a translation sensor disposed proximate said first pulley to measure translational motion of
11 said peripheral by measuring rotation of said first pulley, wherein said peripheral motion assembly
12 manipulates said belt to rotate said first and second pulleys during movement between said first and
13 second supports in response to said translational manipulation of said peripheral;

14 wherein said force feedback unit is disposed proximate said second pulley to apply force
15 feedback to said peripheral in response to control signals from said simulation system by controlling
16 rotation of said second pulley, wherein said second pulley applies a force to said belt in response to
17 said controlled rotation to control translational motion of said peripheral motion assembly, and
18 thereby control translational motion of said peripheral.

1 121. The apparatus of claim 118 wherein said dimension adjustment means includes a

2 bellows and said stabilization means includes a series of openings defined in said bellows for
3 receiving said peripheral and operatively coupling said peripheral to said sensing assembly.

1 122. The apparatus of claim 118 further including first and second supports, wherein said
2 sensing assembly includes:

3 first and second pulleys disposed adjacent said first and second supports, respectively;

4 a belt disposed about and between said first and second pulleys; and

5 a peripheral motion assembly attached to said belt and including said capture mechanism to
6 engage said peripheral, wherein said coupling mechanism is disposed between said peripheral
7 motion assembly and said first support, and wherein said peripheral motion assembly is movable
8 between said first and second supports in response to translational manipulation of said peripheral
9 relative to said interface apparatus and further includes:

10 a rotation sensor to measure rotational motion of said peripheral; and

11 a translation sensor to measure translational motion of said peripheral;

12 wherein said force feedback unit is disposed proximate said first pulley to apply force
13 feedback to said peripheral in response to control signals from said simulation system by controlling
14 rotation of said first pulley, wherein said first pulley applies a force to said belt in response to said
15 controlled rotation to control translational motion of said peripheral motion assembly, and thereby
16 control translational motion of said peripheral.

1 123. The apparatus of claim 118 wherein said peripheral includes a plurality of nested
2 instruments each selectively manipulable by the user and corresponding to a medical instrument, and

3 said interface apparatus further includes:

4 first and second supports;

5 a plurality of said sensing assemblies, each associated with a corresponding nested
6 instrument for measuring manipulation of that nested instrument within the simulated anatomy and
7 providing information associated with manipulation of that nested instrument to the simulation
8 system to enable the simulation system to simulate performance of the medical procedure with said
9 corresponding medical instruments in accordance with said nested instrument manipulation;

10 a plurality of said coupling mechanisms each associated with a corresponding nested
11 instrument for stabilizing said corresponding nested instrument against buckling and operatively
12 coupling said corresponding nested instrument to a corresponding sensing assembly, wherein each
13 said sensing assembly includes:

14 first and second pulleys disposed toward said first and second supports, respectively;

15 a belt disposed about and between said first and second pulleys;

16 a peripheral motion assembly attached to said belt and including said capture
17 mechanism to engage a corresponding nested instrument, wherein said peripheral motion
18 assembly is movable between said first and second supports in response to translational
19 manipulation of said corresponding nested instrument relative to said interface apparatus and
20 further includes:

21 a rotation sensor to measure rotational motion of said corresponding nested
22 instrument; and

23 a translation sensor to measure translational motion of said corresponding
24 nested instrument; and

25 a force feedback unit disposed proximate said first pulley to apply force feedback to
26 said corresponding nested instrument in response to control signals from said simulation
27 system by controlling rotation of said first pulley, wherein said first pulley applies a force to
28 said belt in response to said controlled rotation to control translational motion of said
29 peripheral motion assembly, and thereby control translational motion of said corresponding
30 nested instrument;
31 wherein said peripheral motion assemblies are successively arranged between said first and
32 second supports, and wherein each said capture mechanism is configured to capture a nested
33 instrument of a particular dimension and permit lesser dimensioned instruments to extend through
34 that peripheral motion assembly.

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cont
1 124. The apparatus of claim 118 further including:

2 first and second supports;

3 a plurality of independent peripherals each selectively manipulable by the user and
4 corresponding to a medical instrument;

5 a plurality of said sensing assemblies each associated with a corresponding independent
6 peripheral for measuring manipulation of said corresponding independent peripheral within the
7 simulated anatomy and providing information associated with manipulation of that independent
8 peripheral to the simulation system to enable the simulation system to simulate performance of the
9 medical procedure with said corresponding medical instruments in accordance with said independent
10 peripheral manipulation;

11 a plurality of said coupling mechanisms each associated with a corresponding independent

12 peripheral for stabilizing said corresponding independent peripheral against buckling and operatively
13 coupling said corresponding independent peripheral to a corresponding sensing assembly, wherein
14 each said sensing assembly includes:

15 first and second pulleys disposed toward said first and second supports, respectively;

16 a belt disposed about and between said first and second pulleys;

17 a peripheral motion assembly attached to said belt and including said capture
18 mechanism to engage said corresponding independent peripheral, wherein said peripheral
19 motion assembly is movable between said first and second supports in response to
20 translational manipulation of said corresponding independent peripheral relative to said
21 interface apparatus and further includes:

22 a rotation sensor to measure rotational motion of said corresponding
23 independent peripheral; and

24 a translation sensor to measure translational motion of said corresponding
25 independent peripheral; and

26 a force feedback unit disposed proximate said first pulley to apply force feedback to
27 said corresponding independent peripheral in response to control signals from said
28 simulation system by controlling rotation of said first pulley, wherein said first pulley applies
29 a force to said belt in response to said controlled rotation to control translational motion of
30 said peripheral motion assembly, and thereby control translational motion of said
31 corresponding independent peripheral;

32 wherein said sensing assemblies are arranged in parallel relation within said interface
33 apparatus to measure manipulation of said independent peripherals.

1 125. The apparatus of claim 124 wherein:

2 at least one of said independent peripherals includes a plurality of nested instruments with
3 each nested instrument being selectively manipulable by the user and corresponding to a medical
4 instrument;

5 a plurality of said sensing assemblies are associated with said at least one nested peripheral,
6 wherein each nested peripheral sensing assembly is associated with a corresponding nested
7 instrument to engage, provide force feedback to and measure manipulation of that nested instrument;
8 and

9 a plurality of said coupling mechanisms are associated with said at least one nested
10 peripheral with each associated coupling mechanism stabilizing a corresponding nested instrument
11 against buckling and operatively coupling said corresponding nested instrument to a corresponding
12 sensing assembly.

1 126. The apparatus of claim 124 further including:

2 a mock anatomical site having a plurality of said orifices, wherein each said orifice is
3 associated with a corresponding independent peripheral for receiving that peripheral;

4 a block of resilient material disposed between said mock anatomical site and said coupling
5 mechanisms; and

6 a plurality of guide tubes each associated with a corresponding orifice and extending from
7 that orifice through said block to a corresponding coupling mechanism to guide said independent
8 peripheral associated with that orifice within said interface apparatus;

9 wherein said block provides resiliency to simulate forces and movement of said orifices

10 encountered during performance of the medical procedure.

1 127. An interface apparatus for operatively interconnecting peripherals corresponding to
2 medical instruments to a simulation system to enable a user to interact with the simulation system
3 to perform a medical procedure on a simulated anatomy of a virtual patient, said interface apparatus
4 comprising:

5 a plurality of peripherals each selectively manipulable by the user and corresponding to a
6 medical instrument; and

7 a plurality of sensing assemblies each associated with a corresponding peripheral for
8 measuring manipulation and detecting insertion and removal of that peripheral within the simulated
9 anatomy and providing information associated with manipulation, insertion and removal of said
10 corresponding peripheral to the simulation system to enable the simulation system to simulate
11 performance of the medical procedure with said corresponding medical instruments and exchange
12 of said corresponding medical instruments during the medical procedure in accordance with said
13 manipulation, insertion and removal of said peripherals.

1 128. An interface apparatus for operatively interconnecting peripherals corresponding to
2 medical instruments to a simulation system to enable a user to interact with the simulation system
3 to perform a medical procedure on a simulated anatomy of a virtual patient, said interface apparatus
4 comprising:

5 a peripheral selectively manipulable by the user and corresponding to a medical instrument;

6 a sensing assembly to measure manipulation of said peripheral and transmit information

7 associated with said manipulation to the simulation system to enable the simulation system to
8 simulate performance of the medical procedure with said corresponding medical instrument in
9 accordance with said measured manipulation;

10 a mock anatomical site having an orifice for receiving said peripheral and providing access
11 to said sensing assembly; and

12 a pivoting mechanism to selectively pivot said mock anatomical site into a particular
13 orientation to perform the medical procedure.

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CONT.
129. An interface apparatus for operatively interconnecting peripherals corresponding to
2 medical instruments to a simulation system to enable a user to interact with the simulation system
3 to perform a medical procedure on a simulated anatomy of a virtual patient, said interface apparatus
4 comprising:

5 a peripheral selectively manipulable by the user and corresponding to a medical instrument;
6 a sensing assembly to measure manipulation of said peripheral and transmit information
7 associated with said manipulation to the simulation system to enable the simulation system to
8 simulate performance of the medical procedure with said corresponding medical instrument in
9 accordance with said measured manipulation;

10 a mock anatomical site having an orifice for receiving said peripheral and providing access
11 to said sensing assembly;

12 a block of resilient material disposed between said mock anatomical site and said sensing
13 assembly; and

14 a guide tube extending from said orifice through said block toward said sensing assembly to

15 guide said peripheral within said interface apparatus;

16 wherein said block provides resiliency to simulate forces and movement of said orifice

17 encountered during performance of the medical procedure.

1 130. The apparatus of claim 129 wherein said resilient material includes foam.

1 131. An interface apparatus for operatively interconnecting peripherals corresponding to
2 medical instruments to a simulation system to enable a user to interact with the simulation system
3 to perform a medical procedure on a simulated anatomy of a virtual patient, said interface apparatus
4 comprising:

5 a peripheral having a plurality of nested instruments each selectively manipulable by the user
6 and corresponding to a medical instrument;

7 a plurality of sensing assemblies each associated with a corresponding nested instrument for
8 measuring manipulation of said corresponding nested instrument within the simulated anatomy and
9 providing information associated with manipulation of that nested instrument to the simulation
10 system to enable the simulation system to simulate performance of the medical procedure with said
11 corresponding medical instruments in accordance with said nested instrument manipulation;

12 wherein each said sensing assembly includes a peripheral motion assembly including a
13 capture mechanism to engage said corresponding nested instrument, and said peripheral motion
14 assembly is movable in response to translational manipulation of said corresponding nested
15 instrument relative to said interface apparatus and further includes:

16 a rotation sensor to measure rotational motion of said corresponding nested

17 instrument; and
18 a translation sensor to measure translational motion of said corresponding
19 nested instrument;
20 wherein said peripheral motion assemblies are successively arranged, and wherein each said
21 capture mechanism is configured to capture a nested instrument of a particular dimension and permit
22 lesser dimensioned instruments to extend through that peripheral motion assembly.

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3 132. An interface apparatus for operatively interconnecting peripherals corresponding to
4 medical instruments to a simulation system to enable a user to interact with the simulation system
5 to perform a medical procedure on a simulated anatomy of a virtual patient, said interface apparatus
6 comprising:

7 a plurality of independent peripherals each selectively manipulable by the user and
8 corresponding to a medical instrument;

9 a plurality of sensing assemblies each associated with a corresponding independent
10 peripheral for measuring manipulation of said corresponding independent peripheral within the
11 simulated anatomy and providing information associated with manipulation of that independent
12 peripheral to the simulation system to enable the simulation system to simulate performance of the
13 medical procedure with said corresponding medical instruments in accordance with said independent
14 peripheral manipulation;

15 wherein each said sensing assembly includes a peripheral motion assembly including a
capture mechanism to engage said corresponding independent peripheral, and said peripheral motion
assembly is movable in response to translational manipulation of said corresponding independent

16 peripheral relative to said interface apparatus and further includes:

17 a rotation sensor to measure rotational motion of said corresponding

18 independent peripheral; and

19 a translation sensor to measure translational motion of said corresponding

20 independent peripheral;

21 wherein said sensing assemblies are arranged in parallel relation within said interface

22 apparatus to measure manipulation of said independent peripherals.

B 133. The mechanism of claim 91 wherein said grasping member includes a tubular member
2 disposed between proximal and distal ends of said capture mechanism for engaging said peripheral,
3 and said actuator includes:

4 a spring disposed between said proximal and distal ends of said capture mechanism and over
5 said tubular member to elongate and compress said tubular member in response to translational
6 manipulation of said peripheral relative to said interface apparatus to facilitate adjustment of tubular
7 member cross-sectional dimensions;

8 wherein expansion of said spring in response to insertion of said peripheral within said
9 interface apparatus elongates said tubular member, thereby decreasing said tubular member cross-
10 sectional dimensions to engage said peripheral, and wherein compression of said spring in response
11 to withdrawal of said peripheral from said interface apparatus compresses said tubular member,
12 thereby increasing said tubular member cross-sectional dimensions to release said peripheral.

1 134. The mechanism of claim 133 further including:

2 a disc attached to a distal end of said capture mechanism;
3 a first annular washer disposed proximate and connected to said disc;
4 a second annular washer disposed toward said proximal end of said capture mechanism; and
5 a third annular washer disposed proximally of and connected to said second annular washer
6 for receiving said peripheral;

7 wherein a tubular member distal end is disposed through said first annular washer and
8 attached to said disc and a tubular member proximal end is disposed through said second annular
9 washer and attached to said third annular washer;

10 wherein said spring is disposed between said first and second annular washers to elongate
11 and compress said tubular member in response to translational manipulation of said peripheral
12 relative to said interface apparatus to facilitate adjustment of tubular member cross-sectional
13 dimensions.

1 135. The mechanism of claim 133 wherein said tubular member includes a spirally wound
2 material.

1 136. The mechanism of claim 91 wherein said grasping member includes a plurality of jaws
2 defined in a distal portion thereof to surround and engage said peripheral, and said actuator includes:
3 a spring disposed over said grasping member to bias said jaws to a normally closed state;
4 an expander disposed proximate said spring and having a conical distal end to manipulate
5 said jaws to enter open and closed states; and
6 a pivotable actuator disposed proximate said expander to manipulate said expander to

7 overcome said spring bias and control actuation of said jaws for entry into said closed and open
8 states for capturing and releasing said peripheral.

1 137. The mechanism of claim 136 further including an automatic capture and release
2 mechanism to automatically actuate said jaws to capture and release said peripheral.

1 138. The mechanism of claim 137 wherein said automatic capture and release mechanism
2 includes:

3 a rod connected to said sensing assembly via a friction bracket;

4 a pivotable bracket disposed on said sensing assembly proximate said rod;

5 an actuator extension coupled to said pivotable actuator to control actuation of said jaws to
6 capture and release said peripheral;

7 a support bracket disposed on said rod for manipulating said actuator extension to control
8 actuation of said jaws;

9 a bracket spring disposed between said sensing assembly and said pivotable bracket to apply
10 force to said pivotable bracket to pivot that bracket about said support bracket and manipulate said
11 actuator extension relative to said support bracket to control actuation of said jaws in response to
12 insertion and withdrawal of said peripheral within said interface apparatus;

13 wherein said grasping member captures said peripheral in response to said actuator extension
14 being forced against said support bracket by said pivotable bracket and said bracket spring and
15 releases said peripheral in response to said actuator extension being forced away from said support
16 bracket by said pivotable bracket and said bracket spring.

1 139. The method of claim 92 wherein step (b) further includes:
2 (b.1) operatively coupling the peripheral to the sensing assembly via a coupling mechanism;
3 and
4 (b.2) automatically adjusting coupling mechanism dimensions in response to translational
5 manipulation of the peripheral relative to the interface to facilitate measurement of peripheral
6 manipulation.

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140. The method of claim 92 further including the step of:

(e) applying force feedback to the peripheral in response to control signals from the
3 simulation system.

1 141. The method of claim 139 wherein the interface further includes a mock anatomical site
2 having said orifice for receiving the peripheral and providing access to the coupling mechanism, and
3 step (a) further includes:

4 (a.1) selectively pivoting the mock anatomical site into a particular orientation to perform
5 the medical procedure.

1 142. The method of claim 139 wherein the interface further includes a mock anatomical site
2 having said orifice for receiving the peripheral, a block of resilient material disposed between the
3 mock anatomical site and the coupling mechanism and a guide tube to guide the peripheral within
4 the interface, and step (a) further includes:

5 (a.1) simulating forces and movement of the orifice encountered during performance of the

6 medical procedure by forming a resilient passage within the interface for the peripheral to traverse,
7 wherein step (a.1) further includes:

8 (a.1.1) forming the resilient passage by positioning the guide tube within the interface
9 to extend from the orifice through the block to the coupling mechanism.

1 143. The method of claim 92 wherein the corresponding medical instrument includes an
2 endoscope, and the medical procedure is an endoscopic procedure.

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C 144. The method of claim 143 wherein the peripheral is in the form of an endoscope and
2 includes a working channel, a working channel peripheral selectively manipulable by the user and
3 corresponding to a working channel tool and a sensor to measure manipulation of the working
4 channel peripheral, and step (c) further includes:

5 (c.1) measuring manipulation of the working channel peripheral via the sensor; and
6 step (d) further includes:

7 (d.1) transmitting information associated with the working channel peripheral manipulation
8 to the simulation system to enable the simulation system to simulate performance of the medical
9 procedure with the corresponding working channel tool in accordance with the working channel
10 peripheral manipulation.

1 145. The method of claim 144 further including the step of:

2 (e) applying force feedback to the working channel peripheral.

1 146. The method of claim 143 wherein the peripheral is in the form of an endoscope and
2 includes a navigation tube for insertion into the interface to traverse the simulated anatomy of the
3 virtual patient, a tube position control peripheral selectively manipulable by the user and associated
4 with a distal end of the navigation tube and a sensor to measure manipulation of the tube position
5 peripheral, wherein the distal end of the navigation tube corresponds to a medical tool, and step (c)
6 further includes:

7 (c.1) measuring manipulation of the tube position control peripheral via the sensor; and
8 step (d) further includes:

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9 (d.1) transmitting information associated with the tube position control peripheral
10 manipulation to the simulation system to enable the simulation system to simulate flexing of the
11 navigation tube distal end and operation and positioning of the medical tool within the simulated
12 anatomy during performance of the medical procedure in accordance with the tube position control
13 peripheral manipulation.

1 147. The method of claim 92 wherein the peripheral includes a plurality of nested
2 instruments each selectively manipulable by the user and corresponding to a medical instrument, the
3 interface further includes a plurality of said capture mechanisms each associated with a
4 corresponding nested instrument, and step (b) further includes:

5 (b.1) engaging the nested instruments via the capture mechanisms;

6 step (c) further includes:

7 (c.1) measuring manipulation of each captured instrument within the simulated anatomy via
8 the sensing assembly; and

9 step (d) further includes:

10 (d.1) transmitting information associated with the measured nested instrument manipulation
11 to the simulation system to enable the simulation system to simulate performance of the medical
12 procedure with the corresponding medical instruments in accordance with the nested instrument
13 manipulation.

1 148. The method of claim 92 wherein the interface further includes a plurality of peripherals
2 each selectively manipulable by the user and corresponding to a medical instrument and a plurality
3 of said capture mechanisms each associated with a corresponding peripheral, and step (b) further
4 includes:

5 (b.1) engaging the plurality of peripherals via the capture mechanisms;

6 step (c) further includes:

7 (c.1) measuring manipulation and detecting insertion and removal of each peripheral within
8 the simulated anatomy via the sensing assembly; and

9 step (d) further includes:

10 (d.1) transmitting information associated with the manipulation, insertion and removal of
11 each peripheral to the simulation system to enable the simulation system to simulate performance
12 of the medical procedure with the corresponding medical instruments and exchange of the
13 corresponding medical instruments during the medical procedure in accordance with the
14 manipulation, insertion and removal of the peripherals.

1 149. The method of claim 139 further including the step of:

2 (e) applying force feedback to the peripheral in response to control signals from the
3 simulation system.

1 150. The method of claim 92 wherein the capture mechanism includes a grasping member
2 and an actuator, and step (b) further includes:

3 (b.1) actuating said grasping member via the actuator to engage the peripheral in response
4 to manipulation of the peripheral into the grasping member.

1 151. The method of claim 150 wherein the grasping member includes a tubular member
2 disposed between proximal and distal ends of the capture mechanism, and the actuator includes a
3 spring disposed over the tubular member to elongate and compress the tubular member, and wherein
4 step (b.1) further includes:

5 (b.1.1) decreasing cross-sectional dimensions of the tubular member to engage the peripheral
6 by expanding the spring in response to insertion of the peripheral within the interface; and

7 (b.1.2) increasing the tubular member cross-sectional dimensions to release the peripheral
8 by compressing the spring in response to withdrawal of the peripheral from the interface.

1 152. The method of claim 150 wherein the capture mechanism is disposed within the
2 sensing assembly, said grasping member includes a plurality of jaws defined in a distal portion
3 thereof to surround and engage the peripheral, and said actuator includes a spring disposed over the
4 grasping member, an expander having a conical distal end to manipulate the jaws, and a pivotable
5 actuator to manipulate the expander to actuate the jaws, wherein step (b.1) further includes:

6 (b.1.1) biasing the jaws to a normally closed state via the spring; and
7 (b.1.2) manipulating the jaws to enter open and closed states for capturing and releasing the
8 peripheral by manipulating the pivotable actuator to cause the expander to overcome the spring bias
9 and control actuation of the jaws.

1 153. The method of claim 152 wherein the capture mechanism further includes an automatic
2 capture and release mechanism, and step (b.1.2) further includes:

3 (b.1.2.1) automatically actuating the jaws to capture and release the peripheral via the
4 automatic capture and release mechanism.

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1 154. The method of claim 153 wherein the automatic capture and release mechanism
2 includes a rod connected to the sensing assembly via a friction bracket, a pivotable bracket disposed
3 on the sensing assembly proximate the rod, an actuator extension coupled to the pivotable actuator
4 to control actuation of the jaws, a support bracket disposed on the rod and a bracket spring disposed
5 between the sensing assembly and the pivotable bracket, and step (b.1.2.1) further includes:

6 (b.1.2.1.1) pivoting the pivotable bracket about the support bracket to manipulate the
7 actuator extension relative to the support bracket to control actuation of the jaws in response to
8 insertion and withdrawal of the peripheral within the interface;

9 (b.1.2.1.2) capturing the peripheral in response to the actuator extension being forced against
10 the support bracket during insertion of the peripheral within the interface; and

11 (b.1.2.1.3) releasing the peripheral in response to the actuator extension being forced away
12 from the support bracket during withdrawal of the peripheral from the interface.

1 155. The method of claim 154 wherein the peripheral includes a plurality of nested
2 instruments each selectively manipulable by the user and corresponding to a medical instrument, the
3 interface further includes a plurality of said sensing assemblies each including said capture
4 mechanism and associated with a corresponding nested instrument to measure manipulation of that
5 nested instrument, and wherein the friction bracket of each sensing assembly capture mechanism
6 includes a selectively adjustable friction member, and step (b) further includes:

7 (b.2) engaging the nested instruments via the corresponding capture mechanisms;

8 step (c) further includes:

9 (c.1) measuring manipulation of each nested instrument via the corresponding sensing
10 assemblies; and

11 step (d) further includes:

12 (d.1) transmitting information associated with manipulation of the nested instruments to the
13 simulation system to enable the simulation system to simulate performance of the medical procedure
14 with the corresponding medical instruments in accordance with the nested instrument manipulation;
15 and

16 (d.2) simulating frictional forces encountered between nested instruments during
17 performance of the medical procedure by adjusting frictional forces between the friction bracket of
18 each sensing assembly and a corresponding capture mechanism rod to control resistance applied by
19 that sensing assembly to translational motion of the corresponding nested instrument.

1 156. The method of claim 149 wherein the coupling mechanism includes an inner tubular
2 member disposed within an outer tubular member, the capture mechanism is disposed at a proximal

end of the inner tubular member to engage the peripheral, a distal end of the inner tubular member is attached to the sensing assembly, and step (b.2) further includes:

(b.2.1) automatically adjusting the coupling mechanism dimensions in response to translational manipulation of the peripheral relative to the interface by sliding the inner tubular member relative to the outer tubular member; and

step (c) further includes:

(c.1) measuring manipulation of the peripheral by measuring manipulation of the inner tubular member, wherein the inner tubular member is manipulated in accordance with manipulation of the peripheral.

157. The method of claim 149 wherein step (b) further includes:

(b.3) biasing the capture mechanism to an open state to enable entry and release of the peripheral within the capture mechanism.

158. The method of claim 149 wherein step (b.2) further includes:

(b.2.1) stabilizing the peripheral against buckling during manipulation of the peripheral within the interface to perform the medical procedure.

159. The method of claim 158 wherein the coupling mechanism includes an inner tubular member disposed within an outer tubular and a distal end of the inner tubular member is attached to the sensing assembly, and step (b.2.1) further includes:

(b.2.1.1) stabilizing the peripheral against buckling and automatically adjusting the coupling

5 mechanism dimensions in response to translational manipulation of the peripheral relative to the
6 interface by sliding the inner tubular member relative to the outer tubular member.

1 160. The method of claim 149 wherein the interface further includes first and second
2 supports, the sensing assembly includes first and second pulleys respectively disposed on the first
3 and second supports, a belt disposed about and between the first and second pulleys and a peripheral
4 motion assembly attached to the belt and coupled to the peripheral, wherein the peripheral motion
5 assembly is movable between the first and second supports in response to translational manipulation
6 of the peripheral relative to the interface, and step (c) further includes:

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8 (c.1) measuring rotational motion of the peripheral; and

9 (c.2) measuring translational motion of the peripheral by measuring rotation of the first
10 pulley, wherein the peripheral motion assembly manipulates the belt to rotate the first and second
11 pulleys during movement between the first and second supports in response to translational
12 manipulation of the peripheral; and

13 step (e) further includes:

14 (e.1) applying force feedback to the peripheral in response to control signals from the
15 simulation system by controlling rotation of the second pulley, wherein the second pulley applies a
16 force to the belt in response to the controlled rotation to control translational motion of the peripheral
motion assembly, and thereby control translational motion of the peripheral.

1 161. The method of claim 149 wherein the interface further includes first and second
2 supports, the sensing assembly includes first and second pulleys respectively disposed adjacent the

3 first and second supports, a belt disposed about and between the first and second pulleys and a
4 peripheral motion assembly attached to the belt and coupled to the peripheral, wherein the peripheral
5 motion assembly is movable between the first and second supports in response to translational
6 manipulation of the peripheral relative to the interface, and step (c) further includes:

7 (c.1) measuring rotational motion of the peripheral; and

8 (c.2) measuring translational motion of the peripheral by measuring translational motion of
9 the peripheral motion assembly, wherein the peripheral motion assembly manipulates the belt to
10 rotate the first and second pulleys during movement between the first and second supports in
11 response to translational manipulation of the peripheral; and

12 step (e) further includes:

13 (e.1) applying force feedback to the peripheral in response to control signals from the
14 simulation system by controlling rotation of the first pulley, wherein the first pulley applies a force
15 to the belt in response to the controlled rotation to control translational motion of the peripheral
16 motion assembly, and thereby control translational motion of the peripheral.

1 162. The method of claim 158 wherein the coupling mechanism includes a bellows with a
2 series of openings defined therein, and step (b.2.1) further includes:

3 (b.2.1.1) stabilizing the peripheral against buckling by disposing the peripheral through the
4 openings to operatively couple the peripheral to the sensing assembly.

1 163. In an interface having a plurality of peripherals each selectively manipulable by a user
2 and corresponding to a medical instrument and a plurality of sensing assemblies each associated with

3 a corresponding peripheral for measuring manipulation of that peripheral, a method of enabling the
4 user to interact with a simulation system via the interface to perform a medical procedure on a
5 simulated anatomy of a virtual patient comprising the steps of:

6 (a) operatively coupling the peripherals to the corresponding sensing assemblies;

7 (b) measuring manipulation and detecting insertion and removal of each peripheral within
8 the simulated anatomy via the corresponding sensing assemblies; and

9 (c) transmitting information associated with the manipulation, insertion and removal of the
10 peripherals from the interface to the simulation system to enable the simulation system to simulate
11 performance of the medical procedure with the corresponding medical instruments and exchange of
12 the corresponding medical instruments during the medical procedure in accordance with the
13 manipulation, insertion and removal of the peripherals.

1 164. In an interface having a peripheral selectively manipulable by a user and corresponding
2 to a medical instrument, a sensing assembly to measure manipulation of the peripheral and a mock
3 anatomical site having an orifice for receiving the peripheral and providing access to the sensing
4 assembly, a method of enabling the user to interact with a simulation system via the interface to
5 perform a medical procedure on a simulated anatomy of a virtual patient comprising the steps of:

6 (a) operatively coupling the peripheral to the sensing assembly;

7 (b) selectively pivoting the mock anatomical site into a particular orientation to perform the
8 medical procedure;

9 (c) measuring manipulation of the peripheral via the sensing assembly; and

10 (d) transmitting information associated with the measured manipulation from the interface

11 to the simulation system to enable the simulation system to simulate performance of the medical
12 procedure with the corresponding medical instrument in accordance with the peripheral
13 manipulation.

1 165. In an interface having a peripheral selectively manipulable by a user and corresponding
2 to a medical instrument, a sensing assembly to measure manipulation of the peripheral, a mock
3 anatomical site having an orifice for receiving the peripheral, a block of resilient material disposed
4 between the mock anatomical site and the sensing assembly and a guide tube to guide the peripheral
5 within the interface, a method of enabling the user to interact with a simulation system via the
6 interface to perform a medical procedure on a simulated anatomy of a virtual patient comprising the
7 steps of:

8 (a) operatively coupling the peripheral to the sensing assembly;

9 (b) simulating forces and movement of the orifice encountered during performance of the
10 medical procedure by forming a resilient passage within the interface for the peripheral to traverse,
11 wherein step (b) further includes:

12 (b.1) forming the resilient passage by positioning the guide tube within the interface
13 to extend from the orifice through the block toward the sensing assembly;

14 (c) measuring manipulation of the peripheral via the sensing assembly; and

15 (d) transmitting information associated with the measured manipulation from the interface
16 to the simulation system to enable the simulation system to simulate performance of the medical
17 procedure with the corresponding medical instrument in accordance with the peripheral
18 manipulation.

1 166. In an interface for operatively interconnecting a peripheral to a simulation system to
2 enable a user to interact with the simulation system to perform a medical procedure on a simulated
3 anatomy of a virtual patient, wherein the interface includes a sensing assembly to measure
4 manipulation of the peripheral and transmit information associated with the manipulation to the
5 simulation system, a coupling mechanism to operatively couple the peripheral to the sensing
6 assembly and a capture mechanism having a grasping member and an actuator, a method of engaging
7 the peripheral for interaction with the interface comprising the step of:

8 (a) actuating said grasping member via the actuator to engage the peripheral in response to
9 manipulation of the peripheral into the grasping member.

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1 167. The method of claim 166 wherein said grasping member includes a tubular member
2 and step (a) further includes:

3 (a.1) decreasing cross-sectional dimensions of the tubular member to engage the peripheral
4 by expanding the tubular member in response to insertion of the peripheral within the interface; and

5 (a.2) increasing the tubular member cross-sectional dimensions to release the peripheral by
6 compressing the tubular member in response to withdrawal of the peripheral from the interface.

1 168. The method of claim 166 wherein said grasping member includes a plurality of jaws
2 defined in a distal portion thereof to surround and engage the peripheral, and said actuator includes
3 a spring disposed over the grasping member to bias the jaws to a normally closed position, an
4 expander to manipulate the jaws and a pivotable actuator to manipulate the expander to actuate the
5 jaws to engage the peripheral, and wherein step (a) further includes:

(a.1) actuating the jaws to enter open and closed states for capturing and releasing the peripheral by manipulating the pivotable actuator to cause the expander to overcome the spring bias and control actuation of the jaws.

169. The method of claim 168 wherein the capture mechanism further includes an automatic capture and release mechanism, and step (a.1) further includes:

(a.1.1) automatically actuating the jaws to capture and release the peripheral via the automatic capture and release mechanism.

169. The method of claim 169 wherein the automatic capture and release mechanism includes a rod connected to the sensing assembly via a friction bracket, a pivotable bracket disposed on the sensing assembly proximate the rod, an actuator extension coupled to the pivotable actuator to control actuation of the jaws, a support bracket disposed on the rod and a bracket spring disposed between the sensing assembly and pivotable bracket, and step (a.1.1) further includes:

(a.1.1.1) pivoting the pivotable bracket about the support bracket to manipulate the actuator extension relative to the support bracket to control actuation of the jaws in response to insertion and withdrawal of the peripheral within the interface apparatus;

(a.1.1.2) capturing the peripheral in response to the actuator extension being forced against the support bracket during insertion of the peripheral within the interface; and

(a.1.1.3) releasing the peripheral in response to the actuator extension being forced away from the support bracket during withdrawal of the peripheral from the interface.

1 171. An interface apparatus for operatively interconnecting peripherals corresponding to
2 medical instruments to a simulation system to enable a user to interact with the simulation system
3 to perform a medical procedure on a simulated anatomy of a virtual patient, said interface apparatus
4 comprising:

5 a peripheral selectively manipulable by the user and corresponding to a medical instrument;
6 a sensing assembly to measure manipulation of said peripheral and transmit information
7 associated with said manipulation to the simulation system to enable the simulation system to
8 simulate performance of the medical procedure with said corresponding medical instrument in
9 accordance with said measured manipulation; and

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11 a coupling mechanism for receiving said peripheral and operatively coupling said peripheral
12 to said sensing assembly, wherein said coupling mechanism includes an inner tubular member
13 disposed within an outer tubular member, and wherein said inner tubular member is connected to
14 said sensing assembly and slides relative to said outer tubular member in response to translational
manipulation of said peripheral to stabilize said peripheral against buckling.

1 172. An interface apparatus for operatively interconnecting peripherals corresponding to
2 medical instruments to a simulation system to enable a user to interact with the simulation system
3 to perform a medical procedure on a simulated anatomy of a virtual patient, said interface apparatus
4 comprising:

5 a peripheral selectively manipulable by the user and corresponding to a medical instrument;
6 a sensing assembly to measure manipulation of said peripheral and transmit information
7 associated with said manipulation to the simulation system to enable the simulation system to

8 simulate performance of the medical procedure with said corresponding medical instrument in
9 accordance with said measured manipulation; and

10 a coupling mechanism for operatively coupling said peripheral to said sensing assembly and
11 including a bellows having a series of openings defined therein, wherein said peripheral is disposed
12 through said openings to stabilize said peripheral against buckling during user manipulation of said
13 peripheral.

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1 173. An interface apparatus for operatively interconnecting peripherals corresponding to
2 medical instruments to a simulation system to enable a user to interact with the simulation system
3 to perform a medical procedure on a simulated anatomy of a virtual patient, said interface apparatus
4 comprising:

5 a peripheral selectively manipulable by the user and corresponding to a medical instrument;
6 a sensing assembly to measure manipulation of said peripheral and transmit information
7 associated with said manipulation to the simulation system to enable the simulation system to
8 simulate performance of the medical procedure with said corresponding medical instrument in
9 accordance with said measured manipulation; and

10 a coupling mechanism for receiving said peripheral and operatively coupling said peripheral
11 to said sensing assembly;

12 wherein said coupling mechanism includes a tubular member having a slit with dimensions
13 less than the peripheral dimensions and said sensing assembly extends into said tubular member
14 through said slit to engage said peripheral;

15 wherein said slit maintains said peripheral within said tubular member to stabilize said